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Research Article

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Cane Yield and Sugar Yield Stability in *suru* Sugarcane (*Saccharum officinarum*) Genotypes

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ABSTRACT

The experimental material comprising of seven new genotypes along with three checks were evaluated in six environments, in Peninsular Zone, Maharashtra, India during 2016-17 and 2017-18. Mean squares due to genotypes were highly significant for cane yield (tha^{-1}), CCS yield (tha^{-1}), CCS%, sucrose% at harvest, NMC ('000' ha^{-1}), ACW (kg). The genotypes PDN 13007 and PDN 13011 *along with check variety CoM 0265 were found stable for cane yield (tha^{-1}). The genotypes PDN 13007* and PDN 13002 *along with check variety CoM 0265 was found stable for* CCS *yield (tha^{-1}). The genotype CoVSI 05058* was *found stable for CCS% and sucrose% at harvest. The check varieties Co 86032* and CoM 0265 were found below average stability for the trait NMC. *Hence, the genotypes PDN 13007 and* PDN 13011 *promising lines could be recommended for commercial cultivation or could be suitability used in further improvement programme for cane and CCS yield.*

Keywords: *Stability, Genotypes, Regression coefficient, Deviation from regression, Pooled deviation*

INTRODUCTION

Sugarcane is grown in countries within latitudes of 37^0 N and 32^0 S of the equator. It is an important cash crop as it is widely adapted to a wide range of tropical and semi tropical climate. Productivity of sugarcane is dependent on variety of factors but adoption of new promising genotypes is one of the key factors in production. Though several improved varieties of the crop have been developed, but most of them show inconsistent performance due to genotype x environment interaction. The variations in climate are wide from crop growth to maturity stage. In the extreme weather conditions, the active growth of sugarcane restricted to 4-5 months only. Sugarcane breeders are aware of different performance of sugarcane cultivars in terms of cane yield which vary from region to region and diverse environments. The stable performance of varieties under different season with regard to cane yield has gained considerable significance in sugarcane cultivation.

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The present investigation was planned for identifying high yielding and stable genotypes for cultivation under irrigation command and also for future breeding program. A key goal of sugarcane breeding programs is to increase sugar yield by increasing sugar production per area, which is closely associated with height, diameter and number of the stalk, along with sugar accumulation in the stalk. A promising variety must show high yield and stability in different environmental conditions. This is need to breed genotypes for wide range of environments. Hence, knowledge of genotype x environment interactions is essential for such breeding programme, because potentiality of a genotype and stability of its performance can be judged by multi environmental test. Therefore, present experiment was undertaken to assess the stability of performance of new sugarcane genotypes under six environments in two years.

MATERIALS AND METHODS

The experimental material comprising of seven new genotypes *viz.*, PDN 13001, PDN 13002, PDN 13004, PDN 13007, PDN 13011, CoVSI 05058, VSI 07001 along with three checks CoC 671, Co 86032, CoM 0265) were grown in randomized block design with three replications, in six environments (*Suru* Ist plant) at three locations viz., Central Sugarcane Research Station, Padegaon, Satara, Vasantdada Sugar Institute, Manjri, Pune and Dr. Vitthalrao Vikhe Patil SSK, Pravaranagar, Ahmednagar, Peninsular Zone, Maharashtra, India during 2016-17. The same set was repeated during 2017-18 (*Suru* IInd plant). Each treatment plot comprised 4 rows of 6 m length spaced at 1.20 m apart. The recommended agronomic packages of practices were followed to raise good crops. The observations were recorded for cane yield (tha^{-1}), CCS yield (tha^{-1}), CCS%, sucrose% at harvest, NMC ('000' ha^{-1}), ACW (kg), CCS% and germination % (45 DAP). Phenotypic stability was estimated as per method given by Eberhart & Russells (1966). Total six environmental data taken for stability analysis.

RESULTS

The pooled analysis of variance for phenotypic stability (Table 1) revealed that the mean squares due to genotypes were highly significant for cane yield (tha^{-1}), CCS yield (tha^{-1}), CCS%, sucrose% at harvest, NMC ('000'/ ha) and ACW (kg), when tested against G x E and pooled deviation. Environmental variances and environment linear components of variance were highly significant for all the traits. The mean squares due to linear component *i.e*. genotype x environment linear was significant for the trait net millable canes (NMC). The genotype x environment (non linear) interaction was non significant for all the traits. Mean squares due to pooled deviations (non-linear) were significant for all the characters. The variances due to environment + genotypes x environment were significant for all the traits.

A perusal of phenotypic stability parameters (Table 2) for various traits, the genotypes PDN 13007 and PDN 13011 showed stable performance for cane yield (t/ha). The genotypes PDN 13007 and PDN 13002 were found stable for CCS yield (tha^{-1}). The genotype CoVSI 05058 was found stable for CCS% and sucrose% at harvest. The genotypes CoVSI 05058, VSI 07001 and check variety CoC 671 were found stable for CCS% at 10 month. The check varieties Co 86032 and CoM 0265 were found below average stability for the trait NMC.

DISCUSSION

The mean squares due to genotypes were highly significant for all characters except germination percent, when tested against G x E and pooled deviation indicating the presence of variability in the genotypes for the traits under study. Significant environmental variances suggesting the presence of genetic variability. The linear components environmental variances were indicating that macro environmental differences were present under all the environments. The linear component *i.e*. genotype x environment linear for the trait net millable canes (NMC) indicated that major portion of interaction was linear in nature and prediction over environment would be possible. Mean squares due to pooled deviations (non-linear) indicated that genotypes differed considerably with respect to their stability for all the characters. Kumar et al. (2007) reported significant G x E (linear) for cane yield and sugar yield.

The environment + genotypes x environment variances indicated the role of environments and genotypes environments interaction in predicting stability for all the charcaters. Khan et al. (2002) and Queme et al. (2005) also reported that variance due to environment, genotype and G x E interactions were highly significant for cane yield, sucrose (%) and sugar yield.

The phenotypic stability parameters showed the genotypes PDN 13007 and PDN 13011 along with check variety CoM 0265 was found stable for cane yield (t/ha) as they exhibited regression coefficient (bi) equal to unity (bi =1), non-significant deviation from regression ($S^2di = 0$) and with mean value higher than the population mean for cane yield (tha^{-1}). The genotypes PDN 13007 and PDN 13002 along with check variety CoM 0265 was found stable for CCS yield (tha^{-1}). The genotype CoVSI 05058 was found stable for CCS% and sucrose% at harvest, could be suitability used in further improvement programme for these traits. The genotypes CoVSI 05058, VSI 07001 and check variety CoC 671 were found stable for CCS% at 10 month. The check varieties Co 86032 and CoM 0265 were found below average stability for the trait NMC as regression coefficient (bi) greater than unity (bi>1) with mean value higher than the population mean and non-significant deviation from regression ($S^2di = 0$). Similar results have been reported earlier by Kang & Miller (1984), Bajpai & Kumar (2005), Tahir et al. (2013) Guddadamath et al. (2014) for cane yield and Tiwari et al. (2011) for NMC. These genotypes/varieties were therefore, considered suitable and stable under variable environmental conditions.

Therefore, the genotypes PDN 13007 and PDN 13011 promising lines could be recommended for commercial cultivation or could be suitability used in further improvement programme for cane and CCS yield.

Table 1: Pooled analysis of variance for genotype x environment interactions for different traits in sugarcane (Suru)

Source of variation	d.f.	Mean sum of squares							
		Cane Yield (tha^{-1})	CCS Yield (tha^{-1})	CCS% at harvest	Sucrose % at harvest	NMC '000'ha^{-1}	ACW (kg/ha)	CCS% at 10 months	Germination % (45DAP)
Genotype	9	687.68**	8.94**	1.42**	2.48**	286.41**	0.07**	2.32**	66.23
Environment	5	753.94**	31.02**	3.18**	6.78**	1189.74**	0.14*	10.72**	495.34**
Geno. x Environ.	45	67.02	1.68	0.18	0.25	38.46	0.01	0.31	44.29
Env. + Geno. x Env.	50	135.71**	4.62**	0.48**	0.90**	153.59**	0.02*	1.35**	89.40*
Env (Linear)	1	3769.70**	155.14**	15.94*	33.90**	5948.74**	0.71**	53.60**	2476.70**
Geno. x Environ. (Linear)	9	100.34	1.61	0.13	0.25	79.18**	0.02	0.32	24.24
Pooled deviaton	40	52.82**	1.53**	0.17**	0.22**	25.45**	0.01*	0.28**	44.37**
Pooled Error	108	11.49	0.29	0.03	0.04	4.07	0.001	0.10	5.25
Total	59	219.91	5.28	0.625	1.14	173.85	0.035	1.50	85.86

*, ** Significance at 5% and 1% levels of probability respectively

Table 2: Stability Parameters of 8 traits in sugarcane (Eberhart and Russell's model 1966) (Suru)

	Cane Yield (tha^{-1})			CCS Yield (tha^{-1})			CCS% at harvest			Sucrose % at harvest		
Genotypes	**Mean**	**bi**	**s^2di**	**Mean**	**bi**	**s^2di**	**Mean**	**bi**	**s^2di**	**Mean**	**bi**	**s^2di**
PDN 13001	112.90	0.48	67.70**	15.92	0.58	1.71**	14.08	1.06	0.02	19.83	0.99	0.12*
PDN 13002	129.10	1.09	94.80**	17.82	0.84	0.62	13.82	1.04	0.14**	19.89	1.09	0.23**
PDN 13004	110.40	-0.21	116.60**	15.38	0.40	4.66**	13.89	1.28	0.06	19.48	1.32	0.12*
PDN 13007	136.00	1.28	-6.70	19.14	1.11	0.55	14.02	0.66	0.30**	19.85	0.56	0.11*
PDN 13011	123.00	1.40	10.30	17.32	1.49	0.14	14.02	1.57*	-0.00	19.73	1.46*	-0.00
CoVSI 05058	113.70	1.24	1.60	16.51	0.97	0.06	14.51	0.65	0.00	20.37	0.75	0.03
VSI 07001	109.50	1.30	33.90**	16.15	1.12	2.34**	14.70	0.71	0.27**	20.44	0.73	0.27**
CoC 671©	111.10	1.06	29.80**	16.95	1.15	0.12	15.23	0.91	0.24**	21.38	0.90	0.50**
Co 86032©	121.90	0.85	60.50**	16.95	1.00	1.38**	13.87	1.05	-0.02	19.55	1.07	-0.03
CoM 0265©	137.60	1.48	6.50	18.84	1.28	0.36	13.65	1.02	0.12*	19.16	1.08	0.17*
Population Mean (X)	120.50			17.10			14.18			19.93		
SE (Mean)	3.30			0.55			0.18			0.21		
SE of bi	0.40			0.31			0.33			0.25		

*, ** Significance at 5% and 1% levels of probability respectively

Table 2: Contnd……

	NMC '000'ha^{-1}			Average cane weight (kg)			CCS% at 10 months			Germination % (45 DAP)		
Genotypes	**Mean**	**bi**	**s²di**	**Mean**	**bi**	**s²di**	**Mean**	**bi**	**s²di**	**Mean**	**bi**	**s²di**
PDN 13001	89.72	0.87	1.55	1.40	0.91	0.01**	11.67	1.02	0.63**	60.48	1.34	0.42
PDN 13002	100.65	0.95	13.80**	1.42	0.82	0.01**	11.76	1.16	0.25*	84.17	1.42	20.09**
PDN 13004	95.04	0.88	21.55**	1.27	-0.22*	0.01**	11.81	1.15	0.12	62.23	1.08	22.32**
PDN 13007	103.06	1.07	25.54**	1.52	0.94	0.01**	12.03	0.42*	-0.12	68.80	0.68	18.10**
PDN 13011	97.87	0.93	12.41**	1.43	1.00	0.02**	11.90	1.02	0.02	61.30	0.67	25.64**
CoVSI 05058	84.60	0.38	64.73**	1.34	1.35	0.01**	12.80	0.78	0.31*	61.10	1.23	77.96**
VSI 07001	84.03	0.59	26.86**	1.37	1.90*	0.00	12.65	0.97	0.06	60.24	1.23	54.79**
CoC 671©	85.52	1.26	36.37**	1.37	1.34	0.01**	13.28	1.09	0.02	56.39	1.03	23.70 **
Co 86032©	97.49	1.50*	1.55	1.33	0.51	0.002*	12.22	1.01	0.03	63.89	0.64	16.96**
CoM 0265©	95.45	1.52*	4.61	1.65	1.41	0.03**	11.16	1.33	0.09	64.79	0.63	120.98**
Population Mean (X)	93.34			1.41			12.13			62.34		
SE (Mean)	2.25			0.04			0.23			2.97		
SE of bi	0.20			0.40			0.23			0.42		

*, ** Significance at 5% and 1% levels of probability respectively

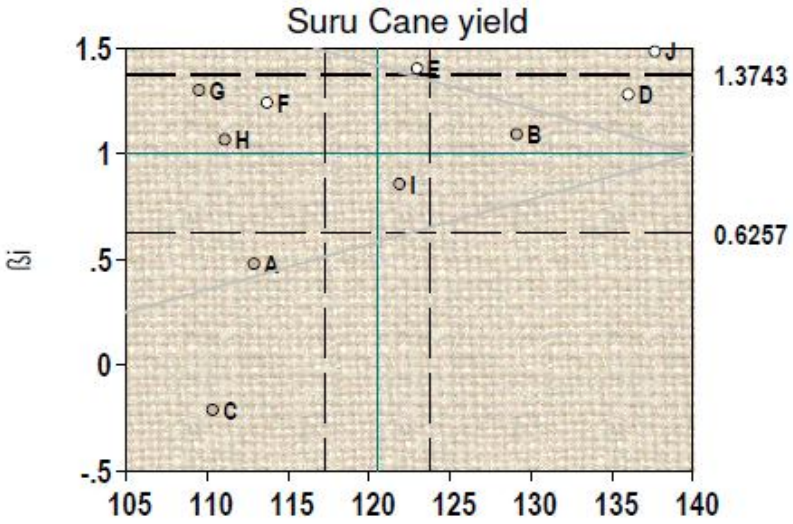

Fig. 1: Regression coefficient of genotypes (A to I) with cane yield

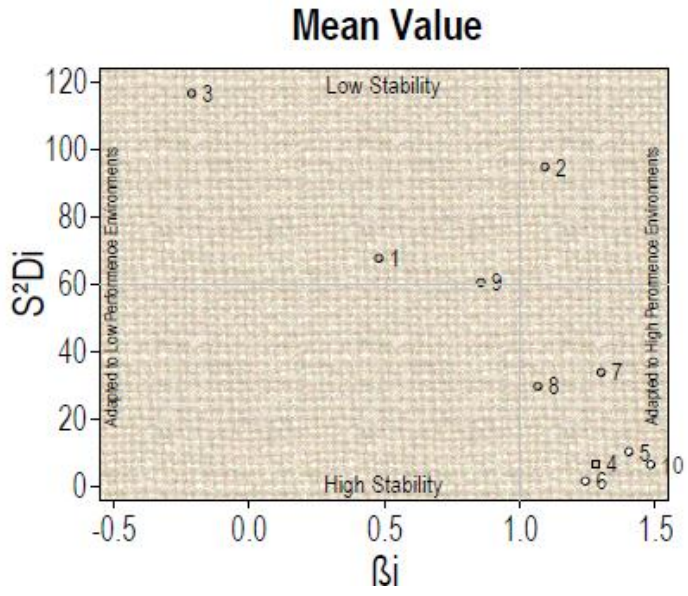

Fig. 2: Deviation from regression of genotypes (1 to 10) with regression coefficient

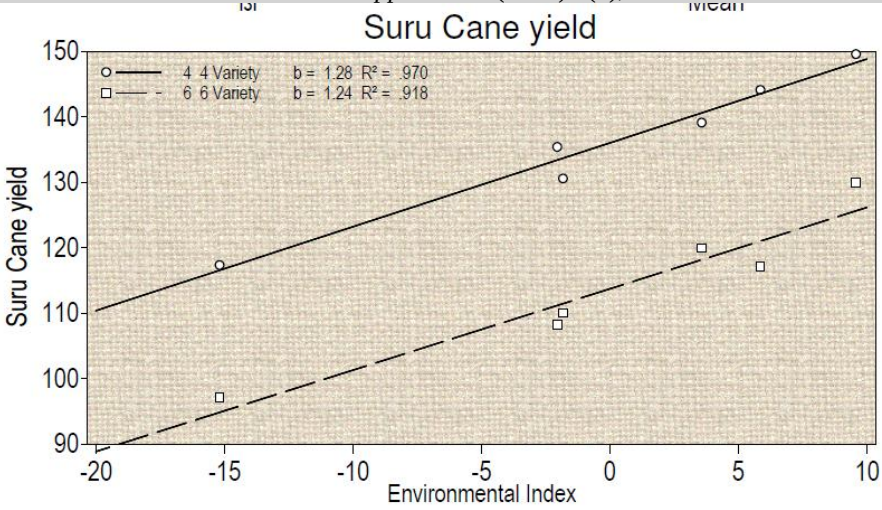

Fig. 3: Cane yield of genotypes with environmental index

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